DOCUMENT RESUME

ED 050 482 EF 003 507

AUTHOR	Evans, John A.
TITLE	The Role of System Analysis in Education Management: A Pragmatic Appraisal and a New Perspective.
INSTITUTION	Operation PEP, Burlingame, Calif.; San Mateo County Superintendent of Schools, Redwood City, Calif.
SPONS AGENCY	Bureau of Elementary and Secondary Education (DHEW/OE), Washington, D.C.
REPORT NO	DPSC-67-4410
PUB DATE	Sep 70
NOTE	55p.
AVAILABLE FROM	Mrs. Elaine Barnes, Director of Education, San Mateo County Office of Education, 590 Hamilton Street, Redwood City, California 94063 ($.50)
EDRS PRICE	EDRS Price MF-$0.65 HC-$3.29
DESCRIPTORS	Decision Making, Educational Administration, Educational Change, Educational Objectives, *Management, *Management Systems, Organizational Change, *Organizational Climate, *Problem Solving, *Systems Analysis, Systems Concepts
IDENTIFIERS	ESEA Title III, Operation PEP

ABSTRACT

This paper explores the potential of systems analysis for the educational manager. It contains a review of systems concepts with comments on current and proper practice. An application model of systems analysis in an organizational context is provided to foster rational decisionmaking and increased skill in problem finding and solving. The limitations and the future of systems analysis are also discussed to provide educational managers with balanced perspectives to assist them in organizational renewal. Funds for this research were provided by an ESEA Title III grant. (Author/RA)

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ED050482

THE ROLE OF SYSTEM ANALYSIS IN EDUCATION MANAGEMENT: A PRAGMATIC APPRAISAL AND A NEW PERSPECTIVE

by
John A. Evans

As Consultant to:

OPERATION PEP: A State Wide Project to
Prepare Educational Planners in California

The work presented or reported herein was performed pursuant to a grant from the U. S. Office of Education, Department of Health, Education, and Welfare. The grant was made under provisions of Title III of the Elementary and Secondary Education Act of 1965 to the San Mateo County Superintendent of Schools through the cooperation of the San Mateo County Board of Education.

September 1970

PROLOGUE

A RECIPE FOR VIOLENCE

Promise a lot; deliver a little. Lead people to believe they will be much better off, but let there be no dramatic improvement. Try a variety of small programs, each interesting but marginal in impact and severely underfinanced. Avoid any attempted solution remotely comparable in size to the dimensions of the problem you are trying to solve. Have middle-class civil servants hire upper-class student radicals to use lower-class Negroes as a battering ram against the existing local political systems; then complain that people are going around disrupting things and chastise local politicians for not cooperating with those out to do them in. Get some poor people involved in local decision-making, only to discover that there is not enough at stake to be worth bothering about. Feel guilty about what has happened to black people; tell them you are surprised they have not revolted before; express shock and dismay when they follow your advice. Go in for a little force, just enough to anger, not enough to discourage. Feel guilty again; say you are surprised that worse has not happened. Alternate with a little suppression. Mix well, apply a match, and run...

Aaron Wildavsky
Professor, Department of Political Science
University of California
Berkeley, California

A POINT OF VIEW THAT OFFERS POTENTIAL HELP

New methods of dealing with complexity have recently become available, and these methods should enable us to deal with larger and more complicated systems.

Everything in the world is, in principle, related to everything else in the world. But, because of our limited rationality and ability to cope with complexity, none of us — scientists, engineers, managers, or anyone else -- can cope with the whole world at once. We, therefore, use the concept of systems to help us out of our dilemma. ...We need, if we possibly can, to define our systems more broadly so as to take into account more of the eventual impacts of our actions on others.

William Pounds
Dean, Sloan School of Management
Massachusetts Insitiute of Technology
Cambridge, Massachusetts

FIGURE 1

STATUS AND TRENDS.
THE EDUCATIONAL SYSTEM REACTION AND CRISIS

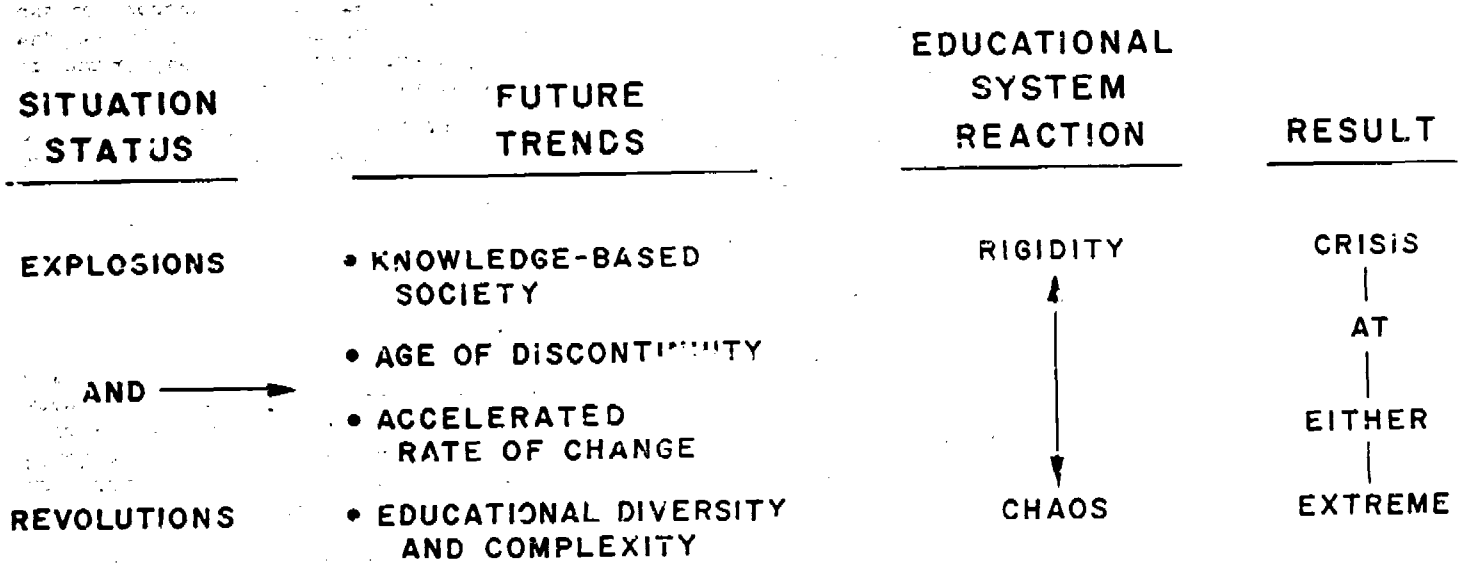


Figure 1

An increasing pace of change is accelerating us toward a knowledge-based society and an age of discontinuity*. The growth of knowledge and computer generated data has resulted in a data if not an information explosion. Technological changes and social revolutions are intensifying and have increased the necessity to introduce a more diverse and complex spectrum of educational services within a local school house. Today's educational institutions as currently organized and managed are increasingly viewed as not being able to cope with the pace and degree of change necessary to take the rational sting out of the growing chorus of critical voices of some parents, teachers, administrators, and students who view the educational system as a "cottage industry"** and the educational services it provides as increasingly irrelevant.

*Drucker, P. F., The Age of Discontinuity. New York: Harper Row, 1968.

**Dr. Leon Lessinger, former Associate Commissioner of Elementry and Secondary Education, USOE, comments as follows: "If we hope to achieve transformation of the educational system in America from its present status as a cottage industry to a center providing modern educational benefits and services, new directions must be launched. We need to seek a new educational tradition by harnessing America's technological and managerial ability, activating community resources and improving educational efficiency and effectiveness."

The response of the educational system (see Figure 1) to these explosions and revolutions, first at the college level, and now repeating itself to some degree at the high school level, has been at times and in some places excessively defensive and rigid (i.e., repressiveness issue). At other times and places, the system has surrendered to irrational pressures resulting in the lack of a coherent management response and chaos (i.e., permissiveness issue). Either extreme type of reaction, regardless of the various causes, has led to the frequent use of the word "crisis" and is indicative of the need for a more appropriate management response to changing educational needs. There appears to be a trend of polarization of opinions toward extreme viewpoints which, if unchecked, will result in a growing crisis of confidence in the way our schools and the society they serve is managed.*

*The need for improved problem finding and problem solving mechanisms is not limited to the educational system and is highly interrelated with the need for improving management renewal efforts within our society - the larger system which to some extent guides and is served by the educational system. John Gardner comments as follows: "Our society, as it is now functioning, is not an adequate problem-solving mechanism. The machinery of the society is not working in a fashion that will permit us to solve any of our problems effectively. Each reformer comes to his task with a little bundle of desired changes --- that is a primitive way of viewing social change. The true task is to design a society (including its educational institutions) capable of continuous change, renewal and responsiveness. We can less and less afford to limit ourselves to routine repair of breakdowns in our institutions. Unless we are willing to see a final confrontation between institutions that refuse to change and critics bent on destruction, we had better get on with the business of redesigning our society."

Thus there is an urgent need to take a fresh, substantive and more systems-oriented look at the underlying causes of these issues and specific problems, starting with the clarification of our educational goals and objectives and culminating with appropriate renewal and reform of our educational organizations and their internal management systems. The purpose of this paper is to be responsive to this need to develop a new perspective and to use new problem finding and solving tools. The paper advocates with caution the use of systems analysis as a managerial aid which, when understood by the manager, can assist in circumventing unnecessary polarization and the crises which lie ahead.

FIGURE 2

ROLES OF SYSTEMS ANALYSIS IN MOVING TOWARD CONTINUOUS SYSTEM RENEWAL

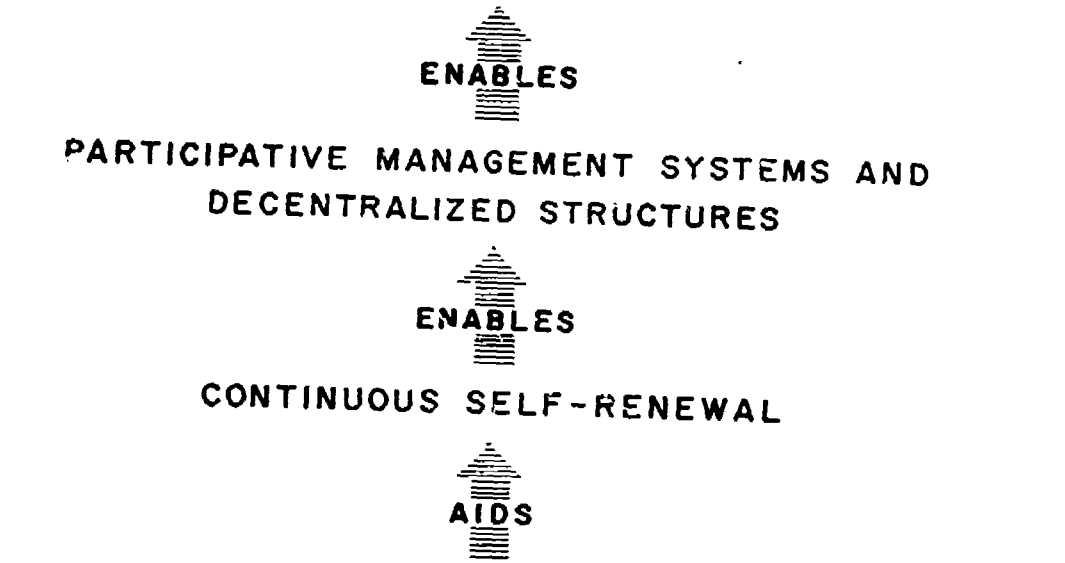


Figure 2

Effective system renewal must be preceded by the self-renewal of those individuals most involved in and held "accountable" for moving from a crisis management mode of operation to the planned management of relevant change. This paper is dedicated to providing the educational manager with a pragmatic perspective (see Figure 2) of the role the systems approach and its tools can play under his leadership.

The advantages as well as the pitfalls and limitations of systems analysis as a tool have been documented in the literature by military and industrial leaders who have used and misused it. Those who refuse to acknowledge its usefulness usually are those who fail to understand that the tool is only as good as the practitioner. Therefore, this paper advocates that the educational manager himself must come to understand the systems concept and systems analysis techniques -- to renew his skills and impact on the renewal of his organization in order that he may do a better job of finding right problems for the management system to solve. His ability to apply interdisciplinary and interpersonal skills to educational problems involves the understanding of new analytical tools such as systems analysis in order to successfully utilize technological products such as management information systems (MIS). He must come to realize that introduction of technology, especially in the case of MIS design and implementation, may first require reform and renewal of the educational organization itself, a point often missed.

FIGURE 3

ORGANIZATION OF PAPER

PART I. ESSENTIAL ASPECTS OF SYSTEMS ANALYSIS

- DEFINITION AND EVOLUTION
- STEPS
- CRITICAL ASPECTS

PART II. SYSTEMS ANALYSIS IN AN ORGANIZATIONAL CONTEXT

- EDUCATIONAL MANAGEMENT AS A MULTI-LEVEL SYSTEM
- EMERGING NEW TOOLS
- FITTING TOOLS TO THE SYSTEM AND ITS PROBLEMS

PART III. TOWARD AN INTEGRATED UNDERSTANDING, TAILORED TOOLS, AND A NEW PERSPECTIVE

- VALUE OF SYSTEMS ANALYSIS
- PITFALLS AND LIMITATIONS
- FUTURE IMPACT AND REORIENTATION OF THE TOOLS
- TOWARD A NEW MANAGEMENT PERSPECTIVE FOR RENEWAL

Figure 3

In order to adequately explore the potential of systems analysis for the educational manager, this paper is organized into three parts as shown in Figure 3. The first part will review essential aspects, commenting on both current and good practice. Part II will highlight the application of systems analysis, in an organizational context, as an aid to the multilevel decision-making process or system*. In Part III the value, pitfalls, limitations and future of systems analysis will be discussed in order to provide the educational manager with a balanced perspective to assist him in his self-renewal as well as in the renewal of his management and organizational systems.

*System, in an organizational context, can be defined as an assembly of interdependent and functionally-related parts (subsystems and megasystems) whose interactions determine its survival and whose broad goals and actual objectives must be understood as a basis for its continued renewal. All (organizational) systems exhibit certain similar characteristics. (1) Every system is part of a still larger system and encompasses many subsystems. Thus, the local education agency as an organizational system is part of a larger system of State government as well as an institutional part of the educational system within the State. Similarly, within the local education agency various organizational units can be viewed as individual systems containing its own subsystems. (2) Most systems - whether physical, biological or social - usually have a general-to-specific, simple-to-complex set of purposes to which all of its parts are designed to contribute. (3) A major characteristic of a system - especially of an organizational system - is that its interdependent interrelationships are complex - in the sense that a change in any variable will effect changes in others - unstructured, and often unknown. Systems can also be defined in terms of key work flows, e.g., inventory and payroll systems, and/or in terms of key management decision-making processes and information flows related to the formulation of a major organizational product, e.g., the planning process leading to the preparation of a budget. All three definitions are useful for identifying management problems associated with renewal. For a more detailed explanation of these concepts see Evans, J., "Educational Management Information Systems: Progress and Perspectives"; Proceedings of Conference on Social and Technological Change: Implications for Education, sponsored by Center for the Advanced Study of Educational Administration and ERIC Clearinghouse on Educational Administration, Fall, 1970.

FIGURE 4

DEFINITION OF SYSTEMS ANALYSIS*

"A SYSTEMATIC APPROACH TO HELPING A DECISION-MAKER CHOOSE A COURSE OF ACTION BY INVESTIGATING HIS FULL **PROBLEM**, SEARCHING OUT OBJECTIVES AND ALTERNATIVES, IN LIGHT OF THEIR CONSEQUENCES, USING AN APPROPRIATE **FRAMEWORK** — IN SO FAR AS POSSIBLE ANALYTIC — TO BRING EXPERT JUDGMENT AND INTUITION TO BEAR ON THE PROBLEM."

* E. S. Quade and W. I. Boucher (eds.), Systems Analysis and Policy Planning (New York: American Elsevier Publishing Company, 1968), p. 2.

Figure 4

Part I: Essential Aspects of Systems Analysis

Systems analysis is both a much used and much abused term. The semantic smoke stems largely from the discipline and experience of the individual using the term, the system and problems being investigated, and the analytic framework being used to assist in generating and evaluating alternatives.

Figure 4 provides a respectable definition of systems analysis as evolved by the organization which pioneered its application to weapons system development and evaluation. The definition can be sufficiently generalized to usefully define and characterize the application of systems analysis to a wide range of problems, including those problems of concern to the educational manager. As we shall soon observe, however, effective application of specific systems analysis concepts, procedures and techniques is highly sensitive to and dependent upon the system analyst's understanding of the problem to be addressed and his understanding of the organizational system in which it is embedded. Because systems differ, for example, the educational system versus a space or weapons system, the difficulty of analyzing them also varies. For instance, a weapons system can be analyzed quite independently of the organization using it while educational systems must be analyzed with a much greater political sensitivity to the organizational system context in which they are embedded. The educational system involves many human components which are easily antagonized by and which react and adapt to the analysis in many subtle and unanticipated ways. A weapons system is less complex in this sense, and can be more easily analyzed according to laws of engineering, mathematics and economics. Thus, the tools used to analyze each must also differ.

A more useful definition of systems analysis when used in an organizational context, i.e., organizational systems analysis, is defined as follows.

> SYSTEMS ANALYSIS: in an organizational context, it is a goal-directed, creative approach to gaining an understanding of the structure of key decision processes within the organization. Some of the major aspects to be considered include an evaluation of its internal operations, its management processes, their relations, and its current and future needs. Both the internal and external analyses attempt to identify key factors — organizational structure and units, critical personnel and their management behavior, information flows and products — their relationships, and their problems (and causes) related to effective management and delivery of educational services. The results of these analyses provide the basis for identifying and reassessing goals and objectives, help to establish criteria for achieving them, and, finally, lay the basis for conceiving and evaluating alternatives which can be implemented in a politically sensitive environment.

This definition of systems analysis as an aid to organizational problem finding and decision making requires significant rethinking of the concept and of the typically used techniques (e.g., PPBS, cost/effectiveness) by analysts and educational managers before they can be "cost/effective" educational management aids. A number of key assumptions commonly glossed over by the new breed of "aerospace practitioners" must be reexamined, a few of which are identified on the following pages.

1. The rather naive assumptions which some economists and organizational theorists hold about decision-making and decision-makers are not valid, i.e., assumptions about "economic man" should give way, in light of recent research on managerial decision-making by Simon* and others, to the notion of the manager as a "satisficing" as opposed to an "optimizing" decision-maker.

2. Use of classic economic utility theory as the sole basis for making more "rational" public policy decision-making should be questioned. Improving the degree of satisficing must involve, for instance, a much more fundamental understanding of the multiple, unstructured, societal goals and a politically sensitive environment where no value consensus exists among many and varied pressure groups to which the educational manager must respond.

3. Sophisticated analytical frameworks or models, i.e., mathematical and simulation models, are rarely an adequate basis for analyzing alternatives which significantly involve human beings.

*Simon, in his highly significant research on how managers actually make decisions, observed that, in contrast to earlier organizational theory which assumes the manager to be an "economic man," the manager acts quite differently. As opposed to living in a world where all his options are known and where all the information needed to choose among them is at his disposal ("economic man" assumption), he, in fact, under time pressures and political and organizational constraints, searches for a solution which will work: i.e., "satisfice." The process of "satisficing" thus involves spending sufficient time to conceive several options which meet minimal standards and/or satisfy minimal criteria. It usually is highly intuitive unless aided by a more systematic process such as discussed in this paper. Simon, H.A., Administrative Behavior; New York; The Macmillan Company, 1957.

FIGURE 5

EVOLUTION AND STATUS

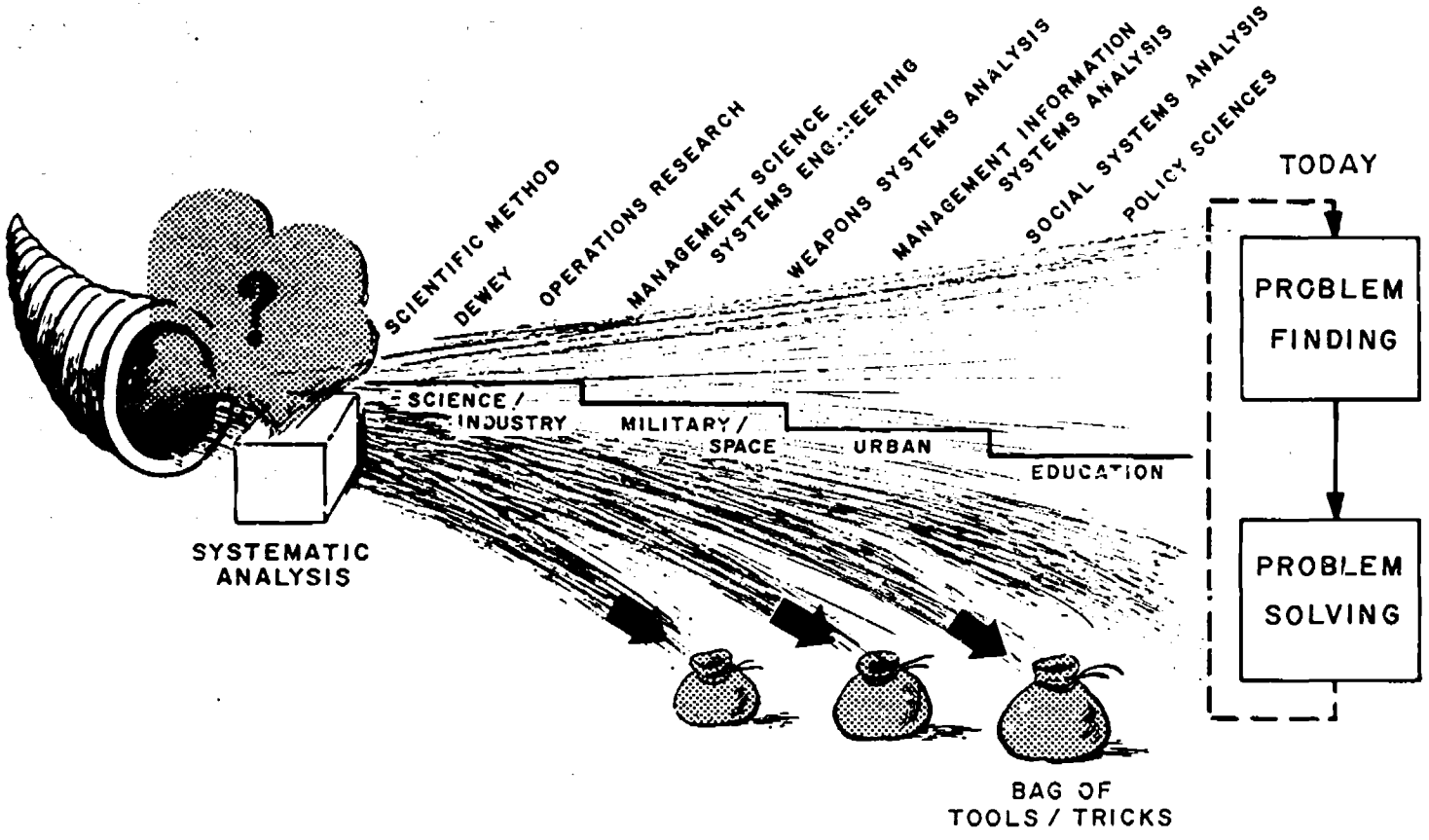


Figure 5

Figures 5 and 6 attempt to highlight the analytical approaches which have contributed to the growing bag of systems analysis tools and the areas to which those tools have been applied. Such tools can be used in varying degrees and combinations by managers and analysts to conduct problem finding efforts and to structure alternative solutions to the problems identified. Unfortunately, too many of the current systems efforts involve the use of inappropriate and/or untailored tools to the solution of ill-defined management problems.

Systems analysis only provides a potentially useful set of tools for the manager. Whether the "tool chest" furnished by the analyst evolves into a "horn of plenty" or a "Pandora's Box" depends on a joint ability to understand and apply them. For the manager this means many things: a systems perspective of his organization, an ability to assemble the right skill mix to tackle the problems, a sense of timing, an appreciation of what is important, and an ability to precisely and logically articulate problems. Such are the requirements necessary to convert what are potentially useful tools into effective aids.

FIGURE 6

STEPS IN PROBLEM FINDING AND PROBLEM SOLVING

MAJOR STEPS	JOHN DEWEY	MANAGERIAL PLANNING	MILITARY STRATEGY	OPERATIONS RESEARCH	DOD WEAPONS SYSTEMS	SYSTEMS ENGINEERING	EVANS / PEP
1		PLAN THE PLAN	—	—	(STRATEGY & TACTICS ANALYSIS)	—	
2		STUDY OPPORTUNITIES, THREATS AND PREPARE OTHER PREMISES	SITUATION OBSERVED	—	—	ENVIRONMENTAL/NEEDS RESEARCH	PROBLEM FINDING
3	WHAT IS THE PROBLEM?	—	—	PROBLEM IDENTIFICATION	MILITARY NEED IDENTIFIED	UNSATISFIED NEED IDENTIFIED	
4		—	MISSION DESCRIPTION	PROBLEM FORMULATION	NEED SPECIFIED	PROBLEM DEFINITION	
5		SET OBJECTIVES	SITUATION OBJECTIVES	CONSTRUCT MODEL	OBJECTIVES DEFINED	SELECT OBJECTIVE CRITERIA	
6	WHAT ARE THE ALTERNATIVES?	IDENTIFY ALTERNATIVE COURSES OF ACTION TO ACHIEVE OBJECTIVES	IDENTIFY ALL FEASIBLE COURSES OF ACTION	DERIVE MODEL SOLUTION	CONCEPT PROPOSALS SOLICITED	SYSTEM SYNTHESIS ALTERNATIVES	PROBLEM SOLVING
7		EXAMINE ALTERNATIVES	ANALYSIS OF EACH COURSE	TEST MODEL AND SOLUTION	CONCEPTUAL AND FEASIBILITY STUDIES	"SYSTEMS ANALYSIS"	
8	WHICH ONE IS BEST?	CHOOSE ALTERNATIVES TO FOLLOW	COMPARE	—	COST/EFFECTIVENESS COMPARISON	COMPARISON	
9		DEVELOP DETAILED PLANS	DECISION ON BEST	ESTABLISH CONTROLS	SELECTION OF BEST	SELECTION	
10		ORGANIZE TO CARRY OUT PLANS	—	REPORT RESULTS	SYSTEM PACKAGE-PLAN DEFINED	COMMUNICATING RESULTS IN PROSPECTUS	
11		CARRY OUT PLANS	—	—	—	—	IMPLEMENTATION & ITERATION
12		REVIEW AND EVALUATE RESULTS	ACTION-PLAN ASSEMBLED	—	ACTION-PLANNING	ACTION-PLANNING	
13		RECYCLE PLANNING PROGRAM	—	—	—	—	

Figure 6

Figure 6 summarizes the variety of systematic procedures which various types of organizations and professionals have used as a basis for problem finding and problem solving. The chart emphasizes the apparent as well as the real differences in the steps conducted during a "systems analysis" effort, thus demonstrating why so much semantic smoke surrounds the concept of systems analysis.

Current systematic approaches tend to oversimplify the complex process of problem finding. Lack of problem finding effort appears to characterize the educational manager as well as his industrial and military counterparts. A corollary to this is that current practice systems analysis and cost/effectiveness studies give too much emphasis to the cost of alternatives and programs, and not enough to providing data that will allow managers to understand the meaning behind "utility numbers" and "figures of merit" so that they can assess the value of those alternatives and programs.*

*In some instances the analyst comes close to living up to H. G. Wells' definition of a cynic - "a man who knows the price of everything and the value of nothing".

FIGURE 7

A CLOSER LOOK AT THE BASIC STEPS TO GOOD PRACTICE

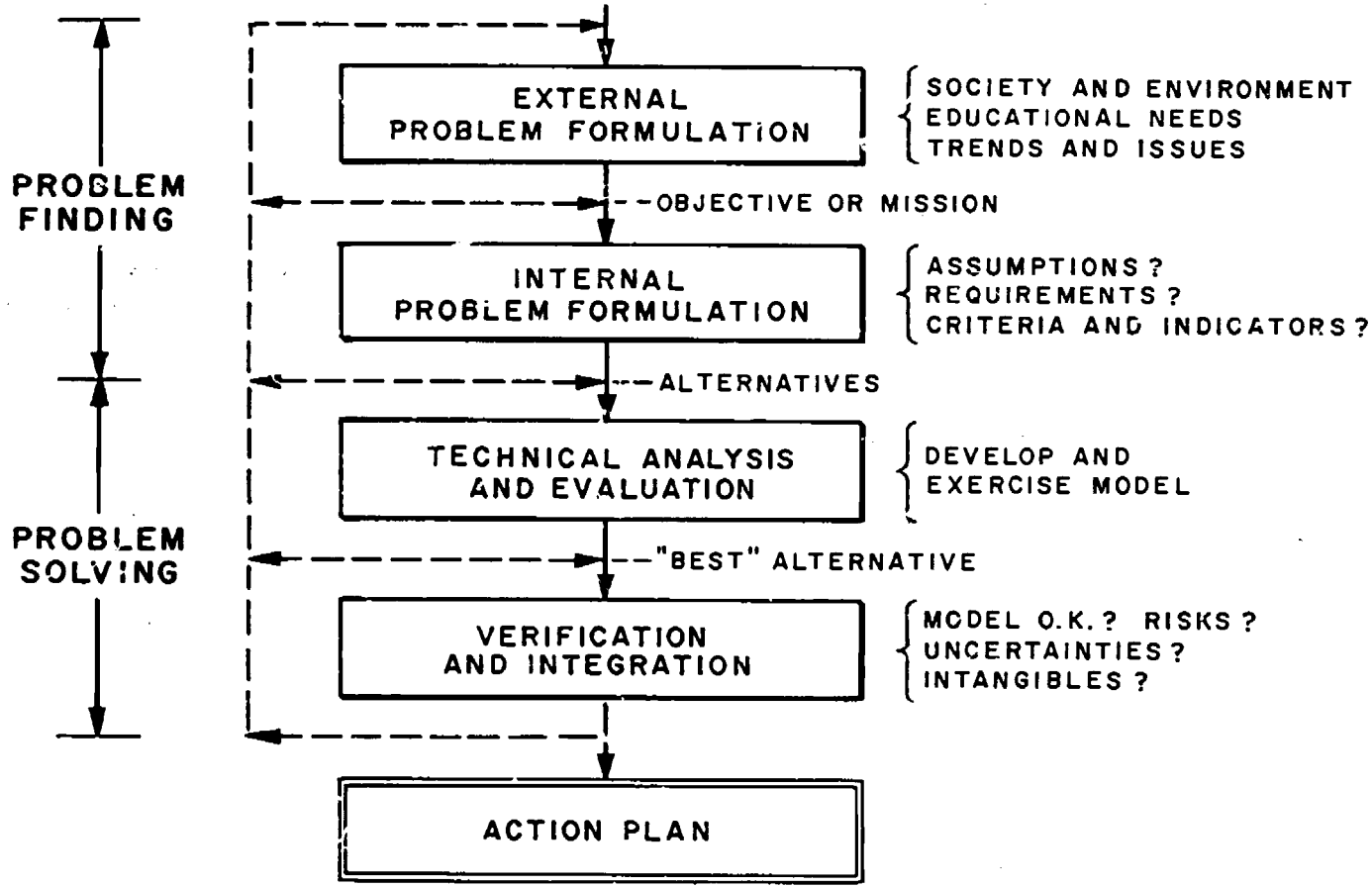


Figure 7

Figure 7 provides a closer look at the basic steps of problem finding and problem solving. It attempts to contrast common practice with good practice. The approach used in common practice usually starts with the appointment of a committee that is constrained by lack of funds or time or data or skill mix, or all four. Without awareness of and/or time to assess future trends and classify and relate current and projected needs, the committee often focuses on formulating internal problems. The assumptions made usually are incomplete because the problem context is too narrow and past-oriented. Organizational and managerial goals and objectives are not appropriately redefined or clarified. Alternative solutions to problems are similarly ill-conceived and often based on the principle of "optionmanship"*. Especially in socio-economic environments such as represented by the educational system the result is often a gross mismatch between needs and funded programs and services.

If the proposed solution involves acquisition of technological aids, especially computer-based management information systems, the results can be costly indeed.

Common practice usually involves a technical analysis and evaluation of alternative solutions. Often the procedure used, such as simulation or narrowly conceived quantitative modeling, is technically sophisticated, but realistically inappropriate. The analytically-oriented evaluation team often tries to tailor the problem to fit the model. The result of the technical analysis

*A form of "one-upmanship" in which three options are presented to the "decision makers" - the first is hopelessly unresponsive; the second is much too costly; and the third is the intended "winner".

and evaluation step is an "optimized" or "best" alternative that is (1) based on limited technical and economic criteria; (2) generated with the assistance of state-of-the-art analytical tools (e.g, computer support if at all possible); (3) based on that data which was readily available in the organization; and (4) amenable to statistical manipulation. The team's final report (or plan) often calls for immediate acquisition and implementation of the innovation (hopefully in someone else's organization) and recommends that additional funds be allocated to further develop the model, which is promised to be shortly generalized and adaptable to many problems confronting the educational manager.

Good practice emphasizes the need for an initial first step -- external problem formulation -- as well as a step which comes between the selection of a best alternative and its implementation - a politically sensitive verification and integration step. The external problem formulation step requires the manager to look beyond the immediate horizon for relevant political, social, and technical trends and issues. The data collected is frequently acquired from organizations other than his own -- the home, the community, the educational policy center, government -- and serves to establish a basis for determining relevant educational needs and issues which may assist the objective-setting committee in crystallizing goals and objectives for a particular state, district or school.

Inclusion of this step alleviates many of the problems associated with the common practice. First, it provides a background and context for the entire effort and the people associated with it. It becomes easier to pragmatically and relevantly characterize the problem to be addressed. Some of the major assumptions, requirements, criteria and measures can now be

identified, resulting in a much better definition and formulation of alternatives. The management steering committee is much more effectively engaged in a dialogue with specialized support personnel to assure that the alternatives being considered are verifiable in a way which can be understood and integrable into existing operations via the action plan. The "optimum" or best alternative is replaced by a "better than we're doing now" alternative, that is more realistically implementable in the politically sensitive environment which awaits its introduction.

Good practice concludes with the verification and integration step which focuses on the conception of a time-phased implementation strategy which in turn leads to an action-oriented operational plan. Inclusion of this step ensures that as changes are conceived, more relevant questions can be asked regarding their applicability to the problem, the usefulness of the model, and the kinds of risks, uncertainties and intangibles associated with evolutionary development. Here, the manager must substantially interact with specialized planning, analysis and/or information-support personnel until he is sure that he understands the value, limitations and pitfalls associated with each alternative proposal, even the one recommended as the "best" or optimal alternative.

FIGURE 8

EVALUATION OF ALTERNATIVES: MODEL SELECTION MULTIPLE DIMENSIONS, CRITERIA, AND INDICATORS

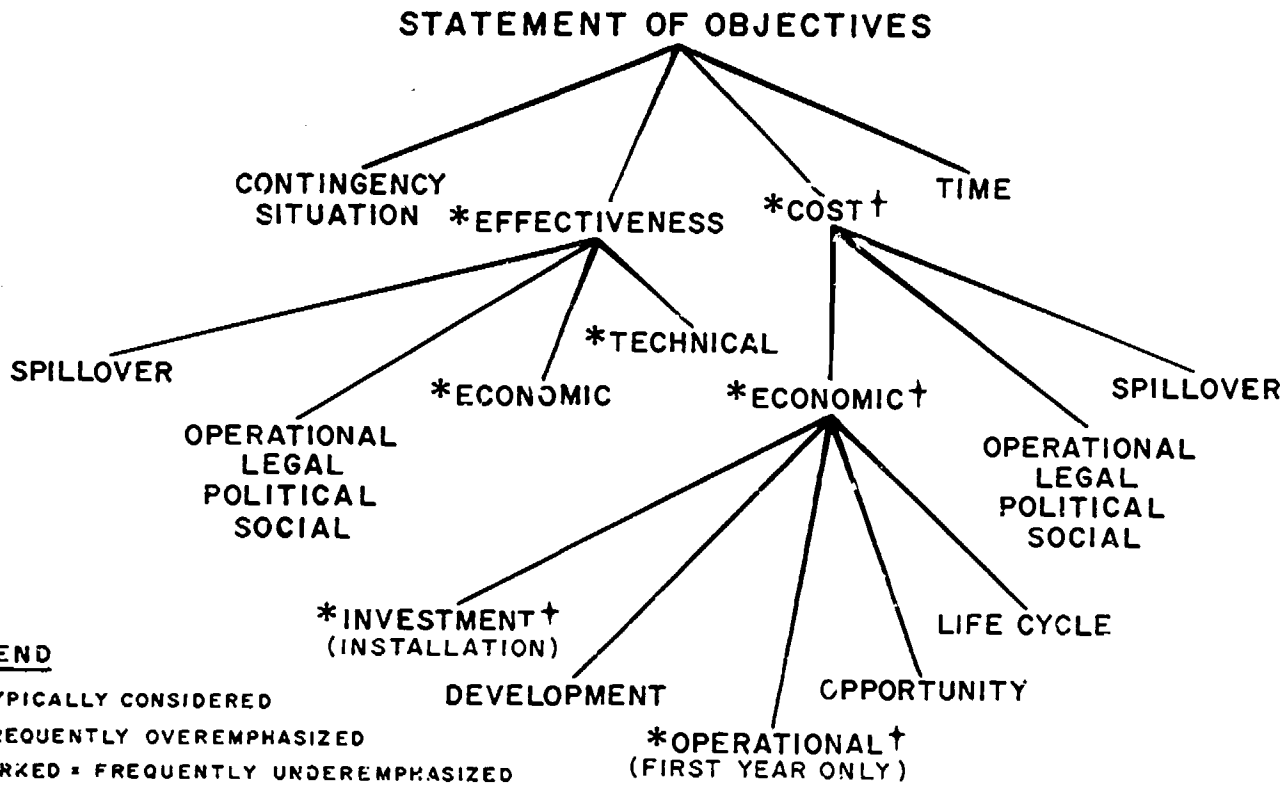


Figure 8

It is beyond the scope of the paper to do more than highlight the critical aspects which (1) differentiate between systems analysis and cost/effectiveness studies and (2) identify key points which enable the manager to differentiate between good and common practice. This is the purpose of this section.

The basic difference between organizational systems analysis and cost/effectiveness studies centers on formulation of objectives -- whether this is a part of the analysis effort or whether the objectives are accepted as "given". A systems analysis study usually has the broader charter. Both efforts can be complex, but the type of complexity is very different: organizational systems analysis is complex because many of the problems, such as those associated with establishing policy or program objectives, are unstructured; cost/effectiveness studies can be complex because they can be extremely sophisticated in terms of the models or evaluation techniques used. Cost/effectiveness studies tend to be introduced at the lower organizational levels where the analysis tasks to be accomplished can be clearly and unambiguously defined. Regardless of what the study is called, an experienced analyst and manager sees the need to mutually agree on the nature and relevance of the objectives to the goals and mission of the organization.

Both types of effort have four aspects or dimensions: cost, effectivess, time and contingency. Often cost receives the greatest emphasis; at its worst, an analysis casts the manager in the role of a cynic who know the price of everything and the value of nothing. Multiple technical aspects of effectiveness usually are exclusively pursued to varying degrees by the

analysis team which, if unencumbered by rational management guidance, will tend to evaluate the problem using only classic economic theory as a conceptual guide and either become absorbed with the perfection of a mathematical or computer-aided analysis model or fascinated with the formulation of an alternative which makes maximum use of sophisticated technology: e.g., the use of computer-aided instruction as opposed to paraprofessionals who may be more appropriate in some circumstances. At the next level down (see Figure 8) are the operational and spillover aspects of cost and effectiveness, aspects not so vigorously considered in many analytical studies. Some of the major reasons for this are that these types of data are frequently unavailable, not easily quantified, and are beyond the analysis team's understanding of the educational system (i.e., frequently viewed by the team as "none of its business").

The remaining two dimensions of a good systems analysis or cost/effectiveness study frequently are underemphasized by managers and analysts alike: the time and contingency dimensions. The time dimension requires projections of the future and an understanding of economic, political and social trends which impact on the organization's direction and, hence, on the alternative ultimately selected. Even brief attention to future events will sometimes cast the analytical studies in quite a different light, focus attention on quite different alternatives, or uncover new types of uncertainties, some of which may not be quantifiable. Contemplation of future events will also assist in identifying various contingency situations (e.g., building of a new jet port or industrial complex or passage of school district redistricting legislation). "Scenarios" that characterize one or more contingency situations in an effort to estimate, for instance, enrollment forecasts and shifts in learner needs may be extremely useful in selecting a realistic and adaptable alternative rather than an "optimal" or "best" alternative which will

be completely useless if the past should not be prologue to the future*. Brief consideration of the contingency and time dimensions of a good analysis may dictate the necessity to reject the more costly and sophisticated models initially recommended by specialized analytical personnel (e.g., school district simulation models) in favor of less sophisticated, conceptual models.

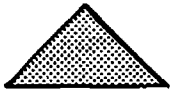
*P. F. Drucker, op. cit., and Warren Bennis in Changing Organizations (New York: McGraw Hill Book Co., Inc., 1966) amply testify that it is no longer possible to compute the future looking backwards using sophisticated statistical techniques. This is still true even if a computer does the computing.

FIGURE 9

MODEL SELECTION

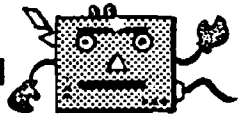
MENTAL

HIERARCHICAL



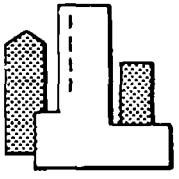
ANALYTICAL $x = f(Y)$

SIMULATION



GAMING

REAL WORLD



INCREASING REALISM AND COST

INCREASING SPEED OF ANALYSIS AND ABSTRACTION

Figure 9

Figure 9 assists in portraying the spectrum of models that could be considered and adapted for a particular study. Mental models (e.g., flow charts) can be readily developed by managers and analysts; their usefulness is a function of completeness in problem definition and of the ability to understand the larger management and organizational system to which a specific problem also relates. They are, however, usually easy and inexpensive to create. Thus, they are attractive alternatives to some of the more sophisticated models that are not only expensive to build or replicate but, more important, may not be available for use during the period allowed for the study. Unfortunately, this type of model suffers from inappropriate abstraction and insufficient consideration of the many dynamic interactions which sometimes must be appreciated.*

In contrast, overemphasis on sophisticated model building and over-reliance on pet techniques is a major pitfall of systems analysis and has contributed to the birth of the phrase "analysis until paralysis". Thus, careful attention should be given to the selection of an appropriate model -- after exploring first the model spectrum or "bag of tools"**.

*Professor Jay Forester, M.I.T., pinpoints this key limitation of the unaided mind: "With a high degree of confidence we can say that the intuitive solutions to the problems of complex social systems will be wrong most of the time."

**In the 1970s a number of educational models will become available in the form of "application packages" to be used interactively on demand over time sharing networks. These new MIS aids will offer considerable assistance to both problem finding and solving but a number of factors will still constrain their usefulness. See J. A. Evans, op. cit.

FIGURE 10

EDUCATIONAL MANAGEMENT AS A MULTI-LEVEL, DECISION-MAKING PROCESS

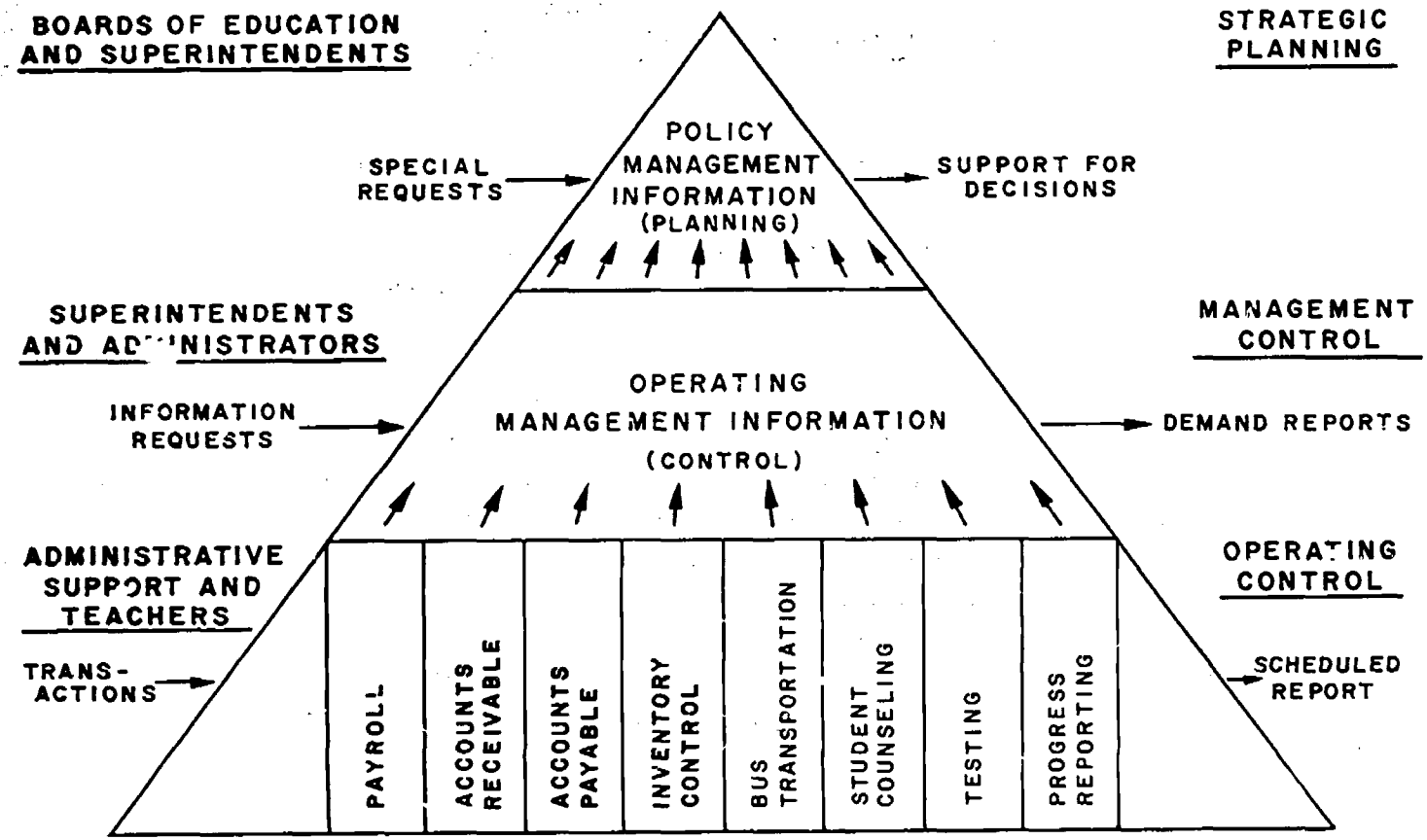


Figure 10

Part II: Systems Analysis in an Organizational Context

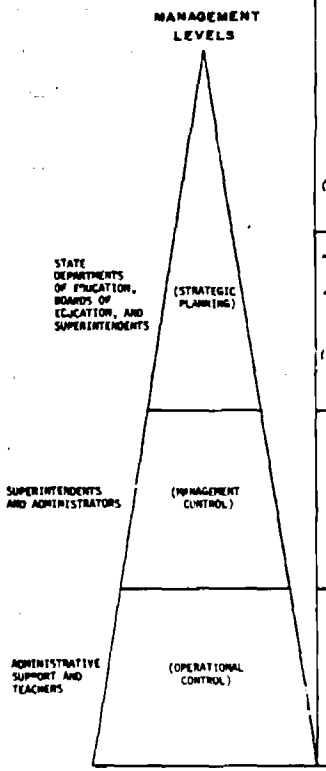
This section discusses the systems perspective necessary for both managers and analysts if they are to use the tools of analysis effectively in addressing management and organizational system problems, including renewal.

The first part of this section will characterize the organizational system as a multilevel decision-making process. This perspective emphasizes that decisions implemented at one level may have far-reaching and unintended effects both on other levels and on the products of the system, e.g., educational services. The second part will provide a glimpse of the new tools and practices available as analysis aids, and the last part will highlight the problems and risks associated with using these new tools.

Figure 10 provides a useful view of the organizational levels, the types and focus of decisions made at each level, and the futurity of those decisions. The greater the futurity, the greater the uncertainties and the more complex the process.

FIGURE 11

NATURE OF ACTIVITIES (AND OUTPUTS) AND DECISION CHARACTERISTICS AT EACH MANAGEMENT LEVEL



		DECISION CHARACTERISTICS CLASSIFICATION SCHEMES										
		SIMON	DRUCKER (CRITICAL ASPECTS)					DEARDEN AND MCFARLEN (DICHOTOMIES)				
ACTIVITIES (AND OUTPUTS)	NATURE	STRUCTURABILITY	FUTURITY	IMPACT	NUMBER OF VARIABLES	UNIQUENESS	FREQUENCY	ACTION VS. NON-ACTION	RECURRING VS. NON-RECURRING	DOCUMENTARY VS. NON-DOCUMENTARY	INTERNAL VS. EXTERNAL	HISTORICAL VS. FUTURE
• SET OBJECTIVES/GOALS • DETERMINE RESOURCES TO BE APPLIED (CONSTRAINTS AND POLICIES)	• UNPREDICTABLE • VARIABLE • STAFF ORIENTED • EXTERNAL PERSPECTIVE	LOW	HIGH	HIGH	HIGH	HIGH	LOW	NON-ACTION	NON-RECURRING	NON-DOCUMENTARY	EXTERNAL	FUTURE
• ALLOCATE ASSIGNED RESOURCES TO TASKS (PLANS AND RULES)	• PERSONAL STYLE • LINE ORIENTED • INTERNAL PERSPECTIVE											
• USE RESOURCES TO CARRY OUT TASKS (ACTIONS AND REPORTS)	• STABLE • LOGICAL • PREDICTABLE • PRESCRIBED	HIGH	LOW	LOW	LOW	LOW	HIGH	ACTION	RECURRING	DOCUMENTARY	INTERNAL	HISTORICAL

Figure 11

Figure 11 spells out in a little more detail the activities carried out at each level, the nature of those activities and their characteristics. At the top, where the activities are not routine and where the variables are many, the decision-making process is characterized by a high degree of complexity and unstructured activity. At the bottom, where the activities are more likely to be routine and stable, the decision-making process is less complex because the cause and effect relationships of highly structurable variables can be more clearly defined*.

*For a more detailed discussion of this subject see footnote and reference on page 9.

FIGURE 12

MASTER "SHOPPING LIST" OF AVAILABLE TOOLS AND PRACTICES

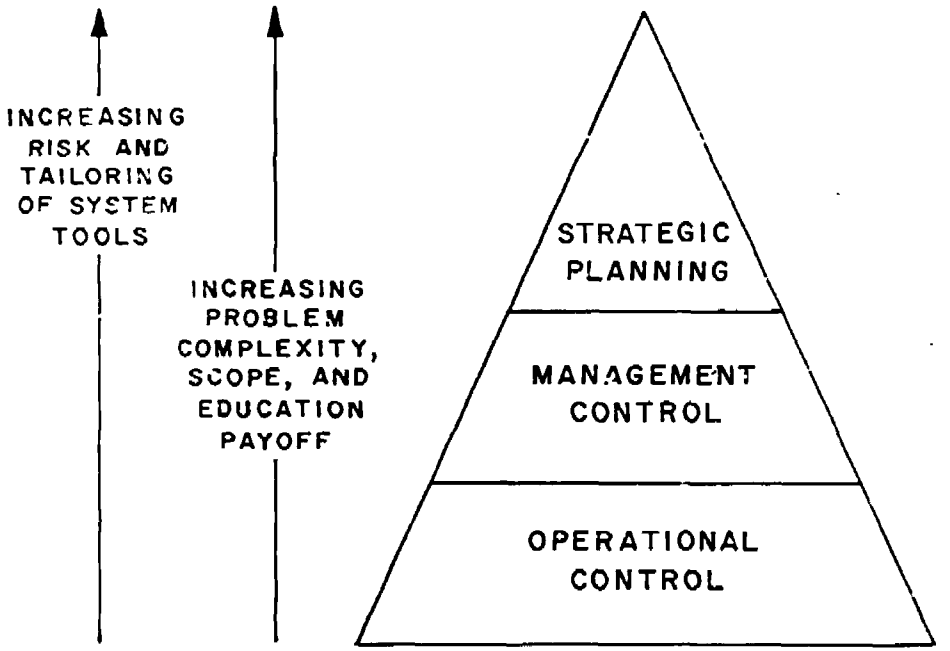
DISCIPLINES	CONTRIBUTIONS				
Information Technology	Calculators Slide Rule		Punched Card Equipment	Service Bureau Time-Sharing CAI	Distributed Configurations
Educational Technology	Projectors Blackboard		AV	Closed-Circuit TV Experimental Schools	Multi-Media Center
Educational Practices	Tutoring	"Standard Classroom Practices"	Differentiated Staffing	Team Teaching	New Tradition "Zero Reject"
Management Practices	Authoritative WORK SIMPLIFICATION		"Theory Y" Incentives	Project/Matrix Organizations Accountability PPBS	Participative
Analytical Concepts and Techniques	Scientific Method	Operations Research	Systems Analysis	Man/Machine Simulation Modeling	

Figure 12

The need for a much broader and more comprehensive understanding of the range of multi-disciplinary tools available to aid the multilevel decision-making process is illustrated in Figure 12. Each row in the figure illustrates tools contributed by some of the various disciplines. (In some cases the tool, for example, PPBS, is the product of more than one discipline.) A major problem is not a lack of tools but an awareness that they already exist, an appreciation of the relevance of specific tools to certain problems, and sufficient knowledge to select and adapt the right set of tools from the "bag of tools". No one person is apt to be equally knowledgeable about the wide range of tools and practices available. Thus, an interdisciplinary team should be selectively assembled, as required, in order to assure that the right mix of tools is being applied to a systematically defined problem area.

FIGURE 13

TOOL TAILORING RISK AND PAYOFF *vs.* ORGANIZATIONAL LEVEL AND PROBLEM



REVISED / NEW INSTITUTIONAL ARRANGEMENTS

EDUCATIONAL MANAGEMENT INFORMATION SYSTEM ANALYSIS

BUDGETARY PLANNING ANALYSIS AND MODELING

SCHOOL DISTRICT OPERATIONS ANALYSIS AND MODELING

CURRICULUM ANALYSIS

TEACHING TECHNICAL ANALYSIS

CLASSROOM / TEACHER / COURSE ALLOCATION ANALYSIS

BUS TRANSPORTATION ANALYSIS

Figure 13

This diagram illustrates a classic and fundamental problem facing all managers: that of risk versus payoff associated with these potentially powerful but easily misapplied system tools. On the right-hand side of the diagram, going from bottom to top, is a sample list of an increasingly complex set of problems faced by managers at various levels. On the left-hand side, the increasing risk of misapplying these tools to problems of increasing complexity and payoff is illustrated.

The crisis atmosphere surrounding and within the educational system today strongly suggests that the definition and resolution of more complex problems can no longer be delayed. To address these problems some of the more sophisticated concepts, practices, and tools (see right-hand side of Figure 12) will be required to define, analyze and alleviate these problems. To delay this task of learning to use and apply relevant but more complex management and systems tools is to risk a growing crisis of confidence. This paper is dedicated to reducing the managerial risk associated with their more timely application to the more complex, but high priority problems facing the educational manager.

FIGURE 14

VALUE OF SYSTEMS ANALYSIS

- SHARPENED INTUITIONS
- RELEVANT ISSUES AND ALTERNATIVES
- HIGH PAYOFFS IN EDUCATIONAL PROBLEM AREAS

Figure 14

Part III: Toward an Integrated Understanding of the Concept, a Tailored Tool and a New Management Perspective for Renewal

Systems analysis, when considered in an organizational context, is primarily concerned with alleviation of higher management-level problems (i.e., strategic planning and management control problems, see Figure 13) that cannot readily be quantified and whose variables are complex and not easily definable. This contrasts with the focus of operations research and management science which tend to emphasize a concern with lower management-level (operational) problems that are better understood structurally and can be addressed quantitatively using existing tools (e.g., linear programming), and where the risk of misuse and the problem of tool-tailoring is not as great. Systems analysis in an information systems context, whether it be an organizational system or not, typically tends to focus on the information-support system to the management decision-making process. Detailed and frequently unjustified assumptions are made about management problems in order to "optimize" computer support to the data management problems assumed to be of importance to the process of management decision making. Finally, systems analysis, as discussed in this paper, differs from the approach typically used by behavioral scientists. They tend to focus exclusively on the human components within the organizational system, giving

little attention to the formal decision making process*. An important goal of systems analysis in an organizational context should be to assist management in structuring heretofore unstructured problems and in assisting to subset and relate their complex nature as a basis for the selection and adaption of proven tools to isolated but relatable subsystems. Good systems analysis has several distinguishing characteristics, as follows:

1. Emphasis on understanding of the organizational problems surrounding a particular decision and a sensitivity to what is implementable.

2. Emphasis on explicitness of the analysis which should include not only technical and economic aspects, but social, legal and political aspects as well.

3. Emphasis on recognition and treatment of uncertainty - all types of uncertainties, political as well as statistical.

4. Emphasis on future trends and issues (crisis anticipation) and derived goal directed action rather than on problem or crisis reaction-directed action.

*The purpose of this discussion is not to artifically differentiate (organizational) systems analysis as a more elite art form but rather to clarify, by exception, its relationship to other approaches so that the many useful insights and tools developed for other specific purposes may be used, as appropriate.

Systems analysis today is used for a number of purposes, some of which relate more to survival (6, 7, and 8) rather than to renewal: for example, (1) exploration of ends/means interactions; (2) clarification of objectives; (3) comparison of alternatives (cost/effectiveness studies tend to concentrate exclusively on this aspect); (4) generation of new alternatives; (5) provision of a framework for discussion; (6) attainment of a bargaining advantage or justification of a position; (7) to embarrass, stall, confuse, educate; and (8) redistribution (frequently unintentially or in unanticipated ways) of power and status within the organization.

Systems analysis has a number of advantages (see Figure 14), the most important being that those who use it are forced to think through their problems from different perspectives and, in so doing develop an integrated systems perspective. Such efforts will assist management to sharpen its intuition and assist in guiding its judgment toward more satisfactory alternatives. Moreover, they will assist management to identify and focus on the relevant issues leading to the conception and detailing of better alternatives and a better choice among those alternatives. Because of its nature, focus and use, it provides the manager with some new tools to address high payoff, high risk, educational problem areas that have for too long gone unattended.

FIGURE 15

PITFALLS AND LIMITATIONS

PITFALLS

UNDER EMPHASIS ON PROBLEM FINDING

INFLEXIBILITY IN THE FACE OF EVIDENCE

PARTY LINE

NOT INVENTED HERE (NIH)

MODEL MISUSE

UNCERTAINTY

INTANGIBLES

LIMITATIONS

COMPLETE ?

MEASURES ?

FUTURE ?

"SCIENTIFIC" ?

Figure 15

Systems analysis unfortunately is no panacea. It is highly dependent upon the interdisciplinary insight, creativity and motivations of the systems analysis task force or the individual system analyst and on a mutual management/analyst understanding of the problem to be addressed. A number of pitfalls* currently limit the effectiveness of analysis (see Figure 15). The major pitfall is the one stressed in this paper -- lack of sufficient attention to addressing and defining high priority, complex problems and their solutions. "Inflexibility in the face of new evidence" is a pitfall in which many individuals and organizations are also mired. The "party line" pitfall refers to cherished beliefs, held by an organization or individual, which overly constrain the range of alternatives which should be considered. The "not invented here" pitfall refers to the human tendency to be blinded by the justified criticisms of one's opinions or inventions. A range of model misuse pitfalls also could be mentioned. Suffice to say that, left to himself, the analyst frequently develops an over-elaborate and not necessarily relevant model which could be easily misused and the conclusions derived from it by management even more easily misinterpreted. Uncertainty is a pitfall, particularly when certain types

*A variation of these basic pitfalls was articulated first by H. Kahn and I. Mann as early as 1957. They are now reappearing with alarming frequency as the "socio-economic complex" becomes systems analyzed. See Hoos, I. R., "A Critique on the Application of Systems Analysis to Social Problems", address presented at the Thirteenth Annual Meeting of the American Astronautical Society, Dallas, Texas, May 2, 1967.

such as statistical uncertainty preoccupy the analyst to the exclusion of other types such as political uncertainty. Finally, lack of attention at some point in the analysis to many intangible but critical aspects affecting the generation and evaluation of alternatives which do not easily lend themselves to quantification is a serious pitfall. In short, an exclusive quantitative focus tends to simplify the problem and warp the clarification of objectives so drastically that sometimes the problem addressed loses all realism and makes more difficult, if not impossible, the appropriate consideration of important intangible aspects.

Regardless of the quality of the analysis, some inherent limitations constrain all systems analyses (see Figure 15). To begin with, analysis is necessarily limited because time, money and other costs obviously place severe constraints on the efforts. Second, measures of effectiveness are inevitably approximate and easily misinterpreted by managers who have not been intimately involved in the analysis. Typically, the more complex and unstructured the problem, the more difficult it is to identify good criteria and measures or indicators of achievement and satisfaction. Another inherent limitation is that systems analysis, especially at the policy formulation level (see Figure 11), tends to deal with the creation and choice of alternatives during some future time period (e.g., the construction of a new school five years hence, a major change in curriculum or organizational structure) and, as most of us have found, the future is not predictable. Finally, systems analysis

is far from an exact science; it is, in fact, only a rationale dependent upon the judgment and intuition of the analyst, the information available about the problem, the constraints placed on him by management, and in turn, the constraints placed on the analyst/management team.

FIGURE 16

THE ANALYST *vs.* MANAGEMENT USER DILEMMA

CRITERIA	ANALYST'S VIEW	MANAGER'S POLITICALLY SENSITIVE VIEW
STUDY OBJECTIVE	USE THE MOST FAMILIAR TOOL	JUSTIFICATION; "SYSTEM ANALYZE THE OTHER GUY"
STUDY TIME	NEVER FINISHED	APPEARANCE OF EFFORT
FUTURE TIME HORIZON	(5 YEARS +) AVOIDANCE OF "FOOT IN DOOR" (PPBS)	(1 YEAR) "QUICK FIX" FOR POLITICAL VISIBILITY
OBJECTIVE	CLARIFY, REDUCE TO ONE WHICH CAN BE QUANTITATIVELY MEASURED	"MESSY MISSION" STRATEGY
ORGANIZATION DESIGN	EFFICIENCY, CENTRALIZATION ?	MAXIMUM CONTROL
COST CONCEPTS	EXCLUSIVE RELIANCE ON ECONOMIC THEORY; OMITS POLITICAL, SOCIAL COSTS	"SUNK" COST COUNTS, SOCIAL COSTS ?
PROGRAM PAYOFF	CONCENTRATE ON SEVERAL HIGH PAYOFF AREAS	"SPREAD IT AROUND"

Figure 16

The future role and impact of systems analysis in educational decision making and public policy decision making in general is primarily dependent upon what contribution it makes to implementable, relevant changes. Implementation of improved decision making processes and educational services is, in turn, dependent upon the ability to the analyst/management team to define the problem and to evaluate the solutions offered with a greater sensitivity to the organizational and political setting. While the manager may be unfamilar with particular system concepts and tools, thus constraining his ability to understand what is being proposed or what has been done, the analyst quite often has much to learn about the ways in which organizations function and managers operate.

The implementation problem can be brought into focus by discussing a key dilemma. A major analyst versus manager or user dilemma (Figure 16) both inhibits the relevancy of many systems analyses as well as the chances of implementing them, at least as intended by the analyst. This major dilemma results from the very different points of view held by the analyst and the manager, and must be resolved before systems analysis studies can make a significant impact (i.e., be implemented) on the decision making processes within a particular organization. The extreme points of view held, on the one hand, by a naive analyst and, on the other, by a politically sensitive manager, who is perhaps concentrating a bit too much on his exclusive survival and power status within an organization, is shown in Figure 16. Various criteria serve to illustrate the multiple dimensions of the dilemma.

In regard to study objectives, the analyst tends to use the tool most familiar to him*, while the manager sees the entire analysis as a "justification" exercise or as a opportunity to "system analyze the other guy" (internal peer managers).

In regard to study time, the analyst is never finished and tends to want more money and time to improve his model and data collection activities, while the manager might well have preconceived notions about terminating the analysis, regardless of the consequences, after showing an "appearance of effort" (cost/effectiveness studies are still fashionable in some parts of the country).

In regard to future time horizon, the analyst tends to focus on radical changes and on longer range life cycle costs of the system being acquired or improved while the manager is interested in making "quick fix" adjustments which are immediately politically visible and not necessarily of major importance.

*Abraham Kaplan, in his Conduct of Inquiry (San Francisco: Chandler Publishing Company, 1964), when commenting on the dangers of using pet behavioral science techniques (which applies to systems analysis techniques as well) formulated the "law of the instrument": "Give a small boy a hammer, and he will find that everything he encounters needs pounding. It comes as no particular surprise to discover that a scientist formulates problems in a way which requires for their solution just those techniques in which he himself is especially skilled."

In regard to objectives, that analyst with little experience in analyzing organizational systems tends to oversimplify the clarification process and/or focus on the first one found which also can be quantitatively treated when defining organizational or program goals/objectives. In contrast, the manager has a complex set of personal and organizational objectives and a subtle strategy for survival which is, in part, accomplished by wearing an assortment of "hats", and so likes to keep his "mission messy".

In regard to organizational design, the analyst may tend to be overly preoccupied with making today's operation more efficient (versus effective) and tends to advocate centralized decision making* in order to simplify, for instance, data management and control problems, while the manager is concerned with maximizing control (e.g., decentralizating responsibility down to his level and centralizing control thereafter).

In regard to cost, the analyst tends to rely exclusively on economic theory and exclude political and social costs from his considerations, while the manager tends to be very concerned with "sunk" costs (i.e., costs associated with decisions made in the past and which theoretically are not relevant to future decisions), especially if the manager's reputation is involved.

*This observation was also recently noted by E. S. Quade (in "The Systems Approach and Public Policy," The RAND Corporation, Santa Monica, California, March 1969) when in referring to California's multimillion-dollar investment in state wide systems studies, he comments: "Nothing much has resulted from these in the way of action. But it is interesting to note that somewhere among their findings, each study calls for an increase in centralized authority; some go so far as to ask that some sort of 'environmental' manager or czar be set up."

Finally, the Systems analyst tends to advocate concentrating resources on a few of the higher payoff areas regardless of political risks to managers, while the manager, in allocating his budget including those resources devoted to analysis, tends to want to "spread it around" on a number of projects in order to be responsive to various pressure groups and to increase the chances of at least one successful program payoff.

Resolution of this dilemma and the establishment of a much more realistic and effective analyst/manager dialogue, leading to a greater impact of systems analysis studies, will necessitate changing the emphasis: the significant tailoring of the existing tools and the reorientation of systems analysis studies. Some of the major changes necessary are highlighted below:

1. from a long-range future and radical change orientation to evolutionary strategies for making progress which are sensitive to time, cost, skill, managerial motivation, power and status constraints;

2. from a problem solving orientation to a problem finding and relating-to-other-systems orientation which encompasses political and social as well as technical and economic factors;

3. from an economics and "hard" (e.g., mathematics, engineering) science orientation to a "soft" (e.g., behavioral sciences) and information science emphasis as well;

4. from a quantative data and tools orientation to a problem-to-be-studied orientation which may give equal or more weight to qualitative and less precise tools that are more comprehensive in scope (e.g., Delphi technique and scenario writing);

5. from an exclusive decision evaluation aspect of decision making orientation to emphasis on a broad, organizational orientation which encompasses the entire multilevel decision making process (e.g., an implementable derivative of PPBS concepts);

6. from a narrowly defined and overemphasized "cost" orientation to a more broadly defined and planned emphasis on "social utility" and political realities orientation;

7. from an assumption of a single decision maker to be served who has unlimited authority orientation to one which assumes multiple decision makers, both inside and outside of the formal organization (i.e., diffused authority among many deicision makers); and

8. from an "economic man" concept of decision making orientation to one which emphasizes the "satisficing" concept of decision making which recognizes that information is costly to collect, unavailable to some, and that options are limited by bureaucratic constraints.

FIGURE 17

FIRST STEPS TOWARD RENEWAL, USING A SYSTEMS PERSPECTIVE (SIMPLE AND PERSONAL TO COMPLEX AND ORGANIZATIONAL)

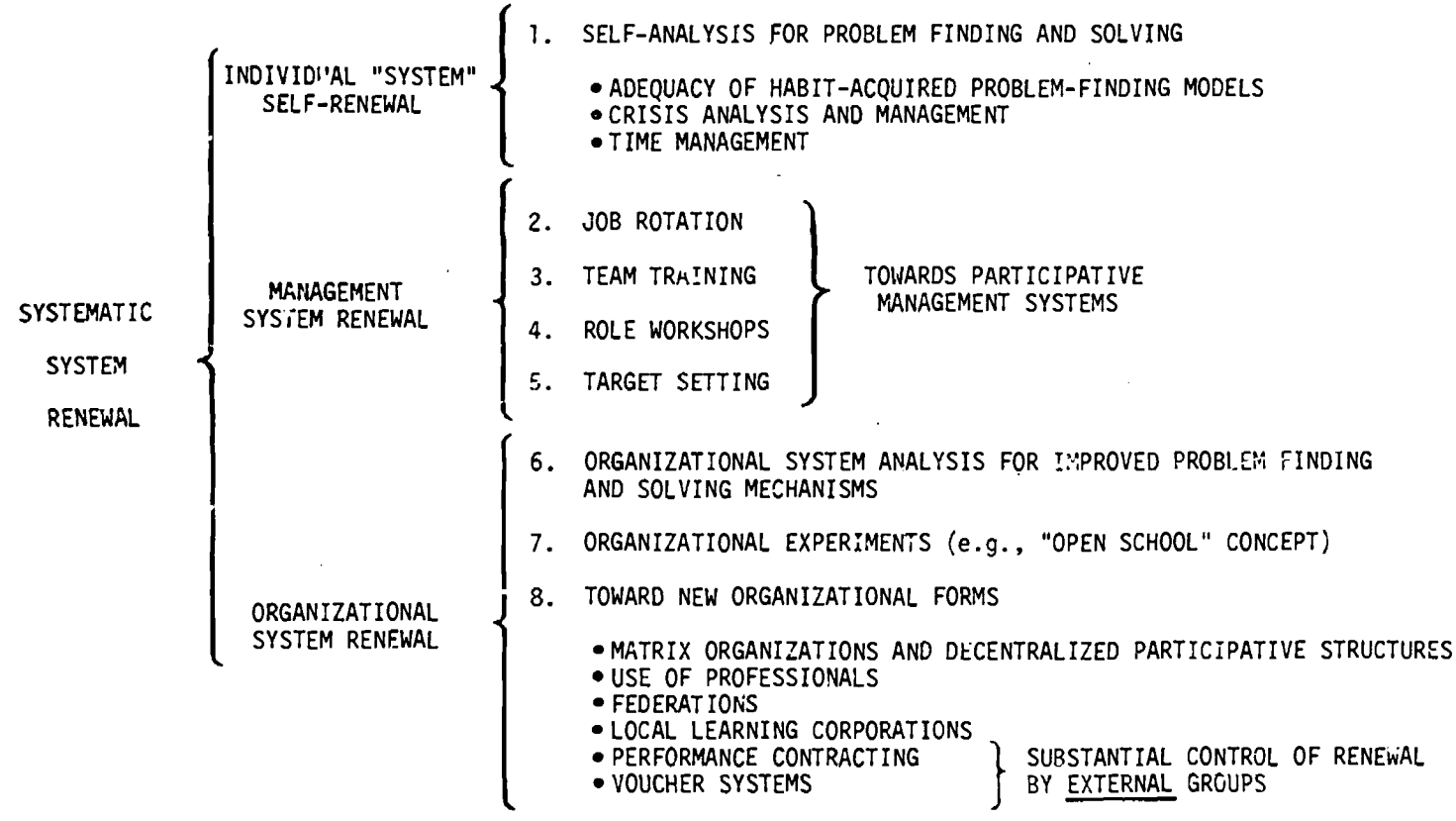


Figure 17

Educational managers, like other managers, have a basic choice as we move toward a knowledge-based society in an age of discontinuity: intensified progress toward systematic renewal (see Figure 17) using more systematic tools (see Figure 5), or continued failure (see Prologue). At this stage of its development, the systems approach, when applied to public policy decision making situations, is probably more like a bundle of concepts and tools in need of varying degrees of clarification and tailoring than a sharply-honed set of tools for structuring the educational management decision making process and unraveling its various and subtle complexities. However, systems analysis when understood by a systems-oriented practitioner who is aware of its value, limitations and needed new emphasis (see page 48), does have clearly identifiable uses and very significant advantages over the more traditional, single discipline-oriented methods of analysis. The interdisciplinary management/analyst task force which uses it should concentrate first on the clarification of educational goals and objectives and next on defining more specifically and comprehensively the multilevel educational management decision making process and its problems. Major surgery will be needed, however, in tailoring information, management and behavioral science tools based on these initial steps if they are to become of significant help to the middle to top educational managers in their problem solving activities.

If the educational manager is not leading the interdisciplinary analysis effort and ultimately involved in using resulting insights which may be derived from it to guide, for instance, the design and implementation of curriculum innovations, systematic system renewal will fail and this failure will continue to fuel more crises.

In conclusion, Figure 17 indicates some first steps toward renewal that can be taken by the manager at three "system" levels starting with his own renewal. Self-renewal involves the application of more systematic and systems-oriented thinking to his individual responsibilities. This self-development program, in turn, will make him a more respected and promotable manager who, as a member of management group will have opportunities to renew the management system. Via promotion or as a member of a task force, for instance, he will have further opportunities to renew the larger organizational system at a later date.

In regard to the first step, which focuses on improving problem finding and solving, the manager should examine the adequacy of his problem finding habits, take the time to do an analysis of the "flaps" in which he becomes involved, and analyze how he spends his time. Steps 2, 3, 4, and 5 advocate a number of management development programs which, in conjunction with systems analysis training, will lead to more effective participative management by objectives. Finally, Steps 6, 7, and 8 are indicative of broader range of educational organization reforms such as matrix forms of organizations. These newer forms can accommodate task force activities which are needed for planned change.

The representative spectrum of organizational reform options identified under Step 8 clearly should convey an urgent message to the education manager. The message is simple stated. If he does not soon individually and collectively advocate and accomplish self-initiated reform -- a systems perspective and its tools being a data organizing and judgement aid to decision making --

other groups external to the formal system will play an increasing role. The result well could be a faster pace and degree of educational reform or a broadening base of accelerating conflict between and within internal and external groups*, resulting in irrational action and further crisis. The point is that the time for self-initiated renewal under the dominant leadership of the education manager -- the most effective kind -- may be running out.

*"For school administrators and committees caught between teachers' constantly escalating salary demands and outraged taxpayers' insistence on seeing "results" for their money, the performance concept has a breathtaking appearance.

As a result, performance contracts, in which outside firms are hired by school systems and paid on the basis of their ability to teach children, are the hottest new item in the edu-biz catalog. Evidence of their popularity is cropping up all over the country.

While teacher's groups claim their opposition to performance contracts is based only on their dedication to the children and the public interest, the unmistakable sound of large and powerful organizations gearing up to protect their own interests can be heard in the background of their protests... Just as the sound of dollar bills softly falling into the cash drawer can be detected through the companies' paeans to educational improvement."
"Education's Cure-all or Profitable Gimmick?" Boston Globe, September 27, 1970.

The challenge and the job are quite clear. The manager of today and of the future -- in industry, government and education -- must be prepared to apply the system approach or perish. The professional system analyst can only support the analysis. The leadership behind the use of this approach must be the men responsible for the educational system and its renewal -- educational managers.

Just as the education of our children is too important to be left exclusively to the teacher, the systems approach when competently used is potentially too valuable to be left exclusively in the hands of a systems analyst.

"The future advance of this new style (systems analysis) is the most significant prediction that can be made about the next ten years."

Max Ways